Contents

Chapter 1	■ Safety	2
Chapter 2	■ Introduction	3
Chapter 3	■ Typical application example	4
Chapter 4	■ Basic SyncPos information	6
Chapter 5	■ Installing the SyncPos PC Software	8
Chapter 6	■ Checking encoder connections	9
Chapter 7	■ Commissioning Guide	11
Chapter 8	■ 10 steps to optimise the PID loop	11
Chapter 9	■ Error and Messages	17
Chapter 10	■ Technical data/wiring examples	25

Safety

■ The voltage of the frequency converter is dangerous whenever the equipment is connected to mains. Incorrect installation of the motor or the frequency converter may cause damage to the equipment, serious personal injury or death.
Consequently, the instructions in this manual, as well as national and local rules and safety regulations, must be complied with.

■ Safety regulations

1. The VLT frequency converter must be disconnected from mains if repair work is to be carried out.
   Check that the mains supply has been disconnected and that the necessary time has passed before removing motor and mains plugs.
2. The [STOP/RESET] key on the control panel of the VLT frequency converter does not disconnect the equipment from mains and is thus not to be used as a safety switch.
3. Correct protective earthing of the equipment must be established, the user must be protected against supply voltage, and the motor must be protected against overload in accordance with applicable national and local regulations.
4. The earth leakage currents are higher than 3.5 mA.
5. Protection against motor overload is not included in the factory setting. If this function is desired, set parameter 128 to data value *ETR trip* or data value *ETR warning.*
   Note: The function is initialised at 1.16 x rated motor current and rated motor frequency (see page 92).
   For the North American market: The ETR functions provide class 20 motor overload protection in accordance with NEC.
6. Do not remove the plugs for the motor and mains supply while the VLT frequency converter is connected to mains. Check that the mains supply has been disconnected and that the necessary time has passed before removing motor and mains plugs.
7. Please note that the VLT frequency converter has more voltage inputs than L1, L2 and L3, when loadsharing (linking of DC intermediate circuit) and external 24 V DC have been installed.
   Check that all voltage inputs have been disconnected and that the necessary time has passed before repair work is commenced.

■ Warning against unintended start

1. The motor can be brought to a stop by means of digital commands, bus commands, references or a local stop, while the frequency converter is connected to mains.
   If personal safety considerations make it necessary to ensure that no unintended start occurs, these stop functions are not sufficient.
2. While parameters are being changed, the motor may start. Consequently, the stop key [STOP/RESET] must always be activated, following which data can be modified.
3. A motor that has been stopped may start if faults occur in the electronics of the VLT frequency converter, or if a temporary overload or a fault in the supply mains or the motor connection ceases.

Warning:

Touching the electrical parts may be fatal - even after the equipment has been disconnected from mains.
Also make sure that other voltage inputs have been disconnected, such as external 24 V DC, load-sharing (linkage of DC intermediate circuit), as well as the motor connection for kinetic back-up.

Using VLT 5001-5006 220 and 500 V units: wait at least 4 minutes
Using VLT 5008-5500 220 and 500 V units: wait at least 15 minutes
Using VLT 5001-5005 550-600 V units: wait at least 4 minutes
Using VLT 5006-5022 550-600 V units: wait at least 15 minutes
Using VLT 5027-5250 550-600 V units: wait at least 30 minutes

About this manual: How is it arranged?

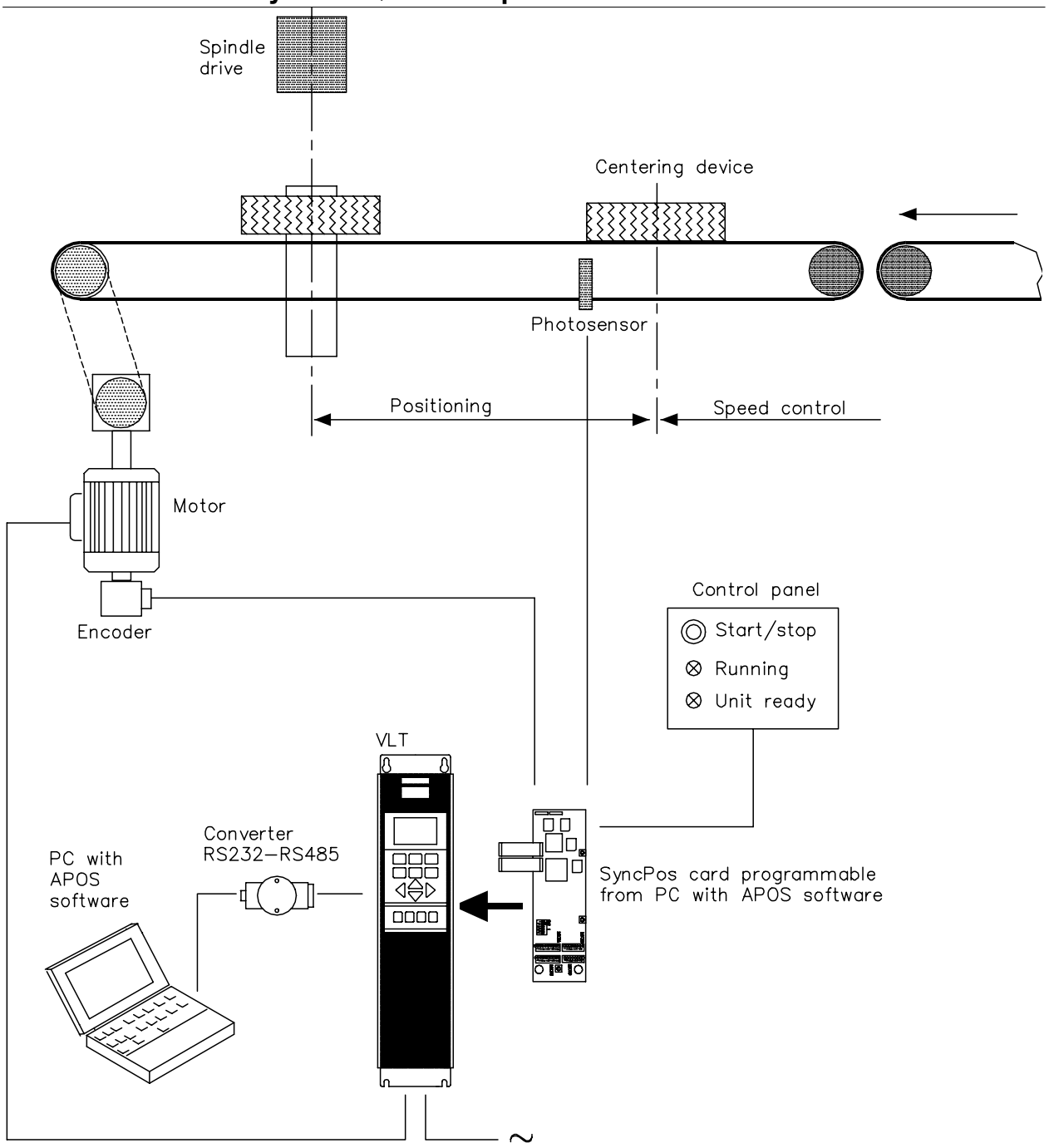
Please read these operating instructions in full and, in order to be able to work with the system safely and professionally, particularly observe the hints and cautionary remarks. It is important to have knowledge about operating a VLT 5000/5000 FLUX.

Indicates a general warning

Indicates something to be noted by the reader

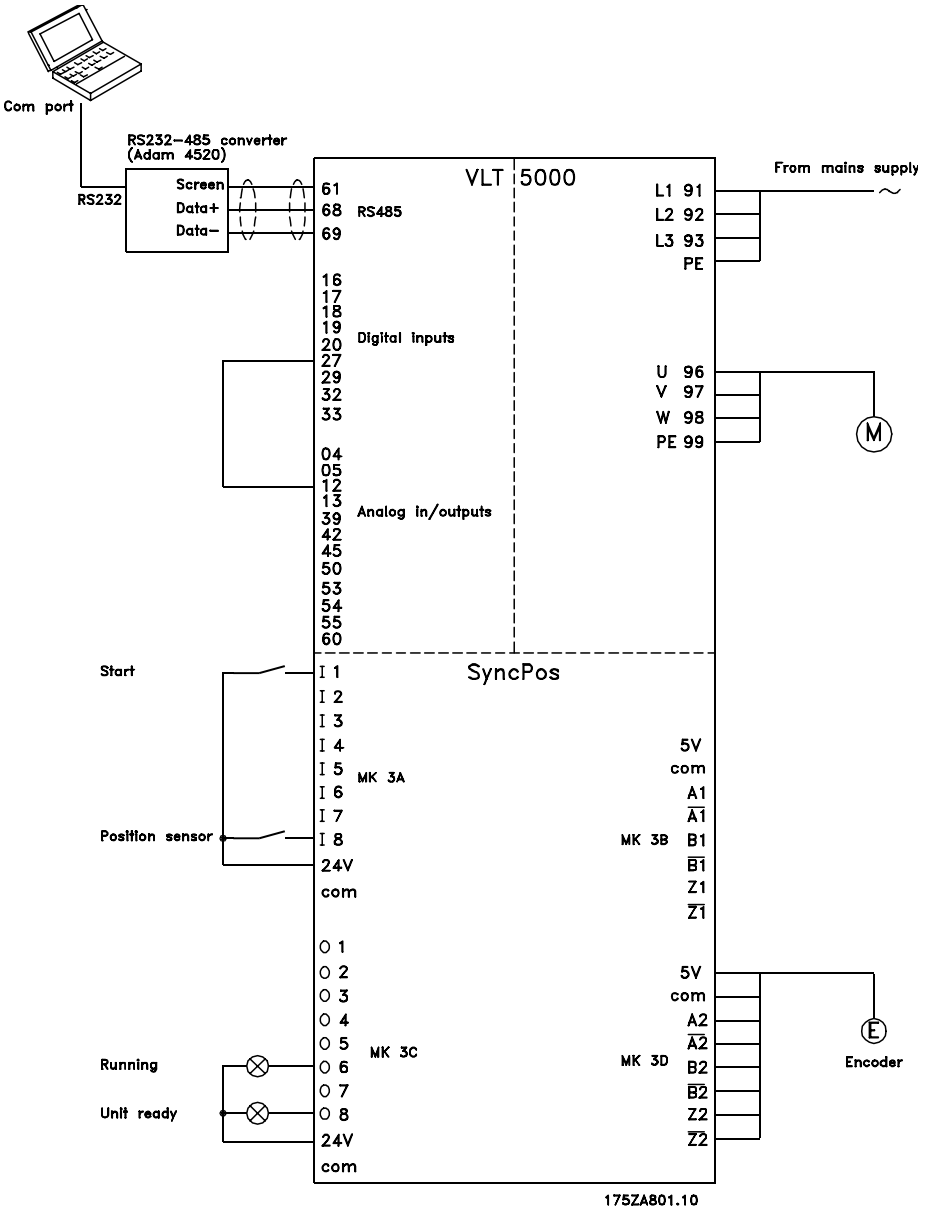
Indicates a high-voltage warning

Typical application example



■ Description in brief

The tire will enter the conveyor belt from the right. This, in turn, will start to run at the same speed as the previous conveyor belt. When the tire reaches the centering station it will stop. The tire will be centered and stays in the waiting position until the machine has finished measuring the "previous" tire. When the measurement is finished, the conveyor and the new tire will be positioned exactly under the spindle. In order to prevent any slippage of the tire, the acceleration and deceleration of the positioning will be controlled by the frequency converter in such a way that we obtain the fastest cycle time without slippage of the tire on the conveyor. A PC is shown connnected to the VLT via RS 485 but this is not needed during normal operation as the APOS program can be stored in the SyncPos card. This picture only shows the minimum required components for a simple positioning application.


Com port
RS232–485 converter
(Adam 4520)
RS232
Screen
Data+
Data–
VLT 5000
61
68
69
RS485
16
17
18
19
20
27
29
32
33
Digital inputs
04
05
12
13
39
42
45
50
53
54
55
60
Analog in/outputs
From mains supply
L1 91
L2 92
L3 93
PE
U 96
V 97
W 98
PE 99
M
SyncPos
Start
I 1
I 2
I 3
I 4
I 5
I 6
I 7
I 8
MK 3A
Position sensor
24V
com
5V
com
A1
Ā1
MK 3B
B1
B̄1
Z1
Z̄1
O 1
O 2
O 3
O 4
O 5
O 6
O 7
O 8
MK 3C
Running
Unit ready
24V
com
5V
com
A2
Ā2
MK 3D
B2
B̄2
Z2
Z̄2
E
Encoder
175ZA801.10

How SyncPos functions

Let us explain the basic principle of SyncPos in brief:

Determining parameters

Factory settings are stored in the program for all parameters. These factory settings are active upon delivery.
You can adjust all the parameters for your controller. These user parameters are permanently saved in the EEPROM and are valid for all programs.
Before you start programming it is necessary to determine basic parameters of the VLT connected, such as ***Maximum velocity*** VELMAX (1) and ***Shortest ramp*** RAMPMIN (31), set the PID filter values and define the ***User factor*** with POSFACT_Z (23) and POSFACT_N (26).
Within a program you can temporarily alter the parameters with the command SET. After running the program these values are once again replaced with the user parameters which have been saved.

Programming with the SyncPos macro-language

In the "EDIT" menu you can create and comment on the programs just like in a text program.
Each command consists of a COMMAND WORD + ***parameter*** (if necessary), whereas the parameter can be a variable, constant or an array.
Comments are written between /* … */ or after // for example:

```
POSA 3000
/* axis absolute to actual zero point move to position 3000 */
// axis absolute to actual zero point move to position 3000
```

It is particularly easy to write your program by using the "COMMAND LIST". Once you have selected the command, all the necessary input fields are immediately opened. After entering the values the syntax is automatically formed and you can insert the entire command in your program.
With teach-in programming you simply move the axis to the desired position and store the position which has been reached. In this manner you can quickly program the most complicated adjustments and sequences of movements.

Running and testing programs

In the "DEVELOPMENT" menu you can test new programs. The program is loaded into the VLT and started only after the "EXECUTE" function has been activated. Naturally, you can run the program being tested in "SINGLE STEPS" or start the program at a certain point and have it executed step-by-step.
Before every run a new program is automatically checked to ensure that the commands are correct. Or you can start the "SYNTAX CHECK" without running the program.

Saving programs in the VLT

Every time you Execute a program or start the syntax check, this program is temporarily stored in the RAM in an area that is always overwritten with every subsequent test.
Once you have finished writing a program for the SyncPos option, the temporary program can be saved permanently in EEPROM. It will then be assigned a number or name and can be tagged with "AUTOSTART" so it automatically will be started after turning on the VLT. This way you can drive the VLT offline.
All programs can also be started using the program number via the inputs, for example from a PLC. For this the inputs must be set accordingly with "CONTROLLER" → "PARAMETERS" → "GLOBAL".

Optimizing the controller with the control parameters

The position control unit integrated in the SyncPos motion controller automatically calculates a theoretical set course during each sequence of movements. The PID loop then controls the VLT to minimize the deviation from the set course. By means of the control parameters you can directly influence to what degree and how quickly a deviation from the theoretical set course is corrected.
The experimental method with the functions in the "TESTRUN" menu can be used to optimize the PID loop.
After every "TESTRUN" it is also possible to evaluate the control parameters on the basis of four graphics: they show the actual and set curves for the velocity, the acceleration, the position and the power curve. Thus, you can successively adjust the PID filter parameters and optimize the controller.

Requirements

SyncPos is for use on standard PC's with operating systems Windows 95, 98, 2000 and XP.
You should be familiar with the basic functions and terminology of the Microsoft Windows interface, for example the **Task bar** and the **Explorer**. You can find further information in the corresponding Windows manuals if necessary.

The SyncPos Window

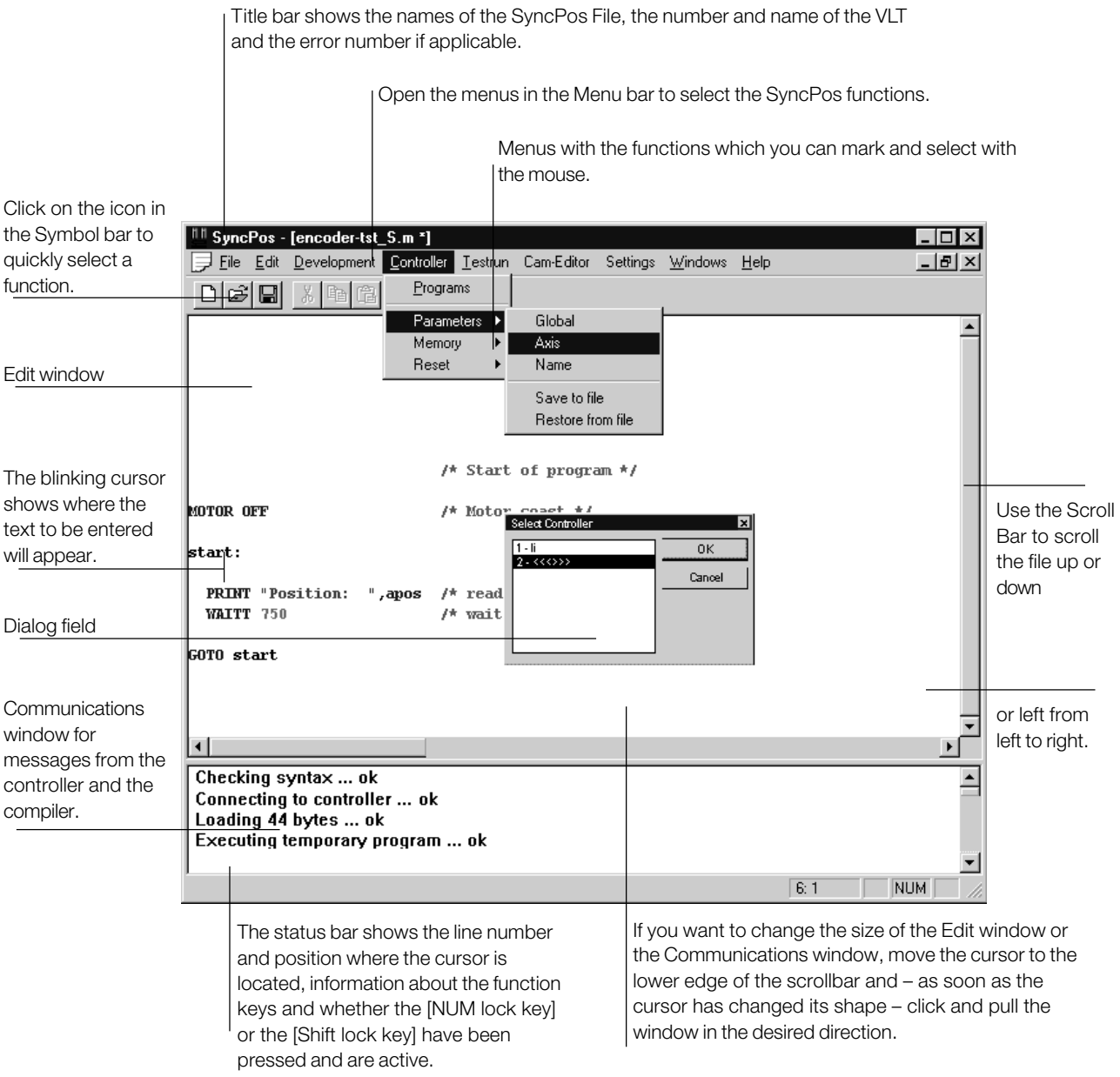
The following figure serves to explain the most important elements of the SyncPos Windows.

Each window represents a SyncPos program which can be connected with a VLT. Thus, you can open at least the same number of edit windows as the number of controllers resp. VLTs you have selected.

Symbol bar

Click on the icons in the symbol bar to quickly select a function.

From left to right: New file, Open file, Save file, Cut, Copy, Paste, Info and CAM-Editor.


Title bar shows the names of the SyncPos File, the number and name of the VLT and the error number if applicable.
Open the menus in the Menu bar to select the SyncPos functions.
Menus with the functions which you can mark and select with the mouse.
Click on the icon in the Symbol bar to quickly select a function.
Edit window
The blinking cursor shows where the text to be entered will appear.
Dialog field
Communications window for messages from the controller and the compiler.
Use the Scroll Bar to scroll the file up or down
or left from left to right.
SyncPos - [encoder-tst_S.m *]
File Edit Development Controller Testrun Cam-Editor Settings Windows Help
Programs
Parameters
Memory
Reset
Global
Axis
Name
Save to file
Restore from file
/* Start of program */
MOTOR OFF
/* Motor coast */
start:
PRINT "Position: ",apos /* read
WAITT 750 /* wait
GOTO start
Select Controller
1 - li
2 - <<<>>>
OK
Cancel
Checking syntax ... ok
Connecting to controller ... ok
Loading 44 bytes ... ok
Executing temporary program ... ok
6: 1
NUM
The status bar shows the line number and position where the cursor is located, information about the function keys and whether the [NUM lock key] or the [Shift lock key] have been pressed and are active.
If you want to change the size of the Edit window or the Communications window, move the cursor to the lower edge of the scrollbar and – as soon as the cursor has changed its shape – click and pull the window in the desired direction.

This section offers you a quick general introduction which includes turning on and familiarizing yourself with the program, how to set up a VLT with SyncPos motion controller using the test programs provided and the most important basic settings.

NB!
O.ERR 13 will show up right after power up if the VLT is not ready. The VLT is in the "Not ready" state when:

- it has an alarm (trip),
- it is in local mode (parameter 002 = local),
- local LCP stip is activated (display flashing),
- there is no signal on input 27 (coast).

O.ERR 13 can only be reset using the ERRCLR command or with "BREAK" [ESC] in the PC software and only when the VLT ist in the "ready" state, which means none of the above may be true.

VLT optimisation

To achieve good control it is important to optimise the VLT. This must be done before positioning or synchronising using SyncPos.

Some VLT parameter factory settings are, when SyncPos is mounted, different to the standard factory settings. A fulle list is included in the SyncPos instruction manual. The instruction manual is included on the SyncPos CD. Note that the ramp times are as short as possible because they act as a filter on the PID loop of SyncPos.

Safety tips

The controller and the motor must be able to be switched off at any time with an EMERGENCY STOP button.

The motor must be able to turn completely freely so that a sudden jolt can not cause damage.

Installing SyncPos

Insert the CD in the CD ROM drive, in the menu click on "INSTALL VLT SOFTWARE SYNCPOS", and "RUN THIS PROGRAM FROM ITS CURRENT LOCATION" and click yes.

Follow the directions given during the installation program and list the hard drive on which SyncPos should be installed. SyncPos and the program samples included will be installed in the directory listed.

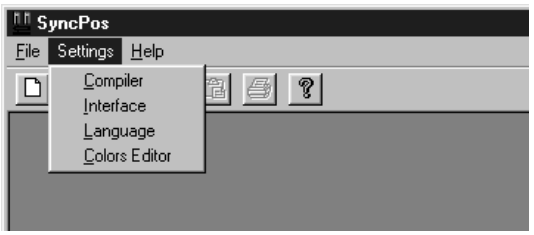
Starting SyncPos

Turn on the VLT, however, make sure the motor is not connected.

In the task bar, click on "START" → "PROGRAMS" → SyncPos.

Changing the dialog language

Now the SyncPos window has been opened – English is the standard dialog language.



If you desire another language, click on "SETTINGS" → "LANGUAGE" (before you open a file) and select for example "GERMAN" in the dialog field which will subsequently appear. "EXIT PROGRAM" and start SyncPos again.

Exit SyncPos

You can only abort or end an APOS program with [ESC]. In order to do this the file which is linked with resp. VLT must be open.

Setting of VLT parameters

During booting the VLT parameters are set to the factory settings. Only the motor parameters remain to be set:
Perform AMA (see VLT5000/VLT5000Flux manual) or manual optimizing of the VLT to the connected motor.

Adjust maximum output frequency in par. 202 (Flux: output speed high limit) and maximum reference in par. 205 according to maximum velocity of the encoder. Note that the maximum output frequency must be higher than the frequency corresponding to maximum allowed velocity of the shaft because of the slip of the motor.

Terminal 27 must be connected to 24 V or parameter 502 must be set to "serial port".

Function of inputs and output must be selected in parameter group 3xx according to the required functions. Note that the default values are different from a drive without option.

Please note that Dead Time Compensation in parameter 780 (not Flux) is set to OFF. This parameter is to prevent oscillation at standstill.

■ Checking encoder connection and direction of rotation

If you have not yet done so, now is the time to connect and test the encoder. In this example it is assumed an incremental encoder is used.

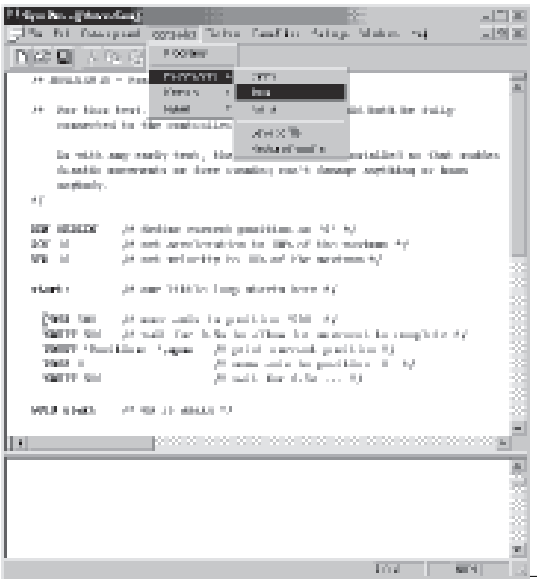
NB!
Remember to turn off the power before connecting the encoder. See "Technical Data/Wiring examples" for encoder wiring.

Preparation for first run

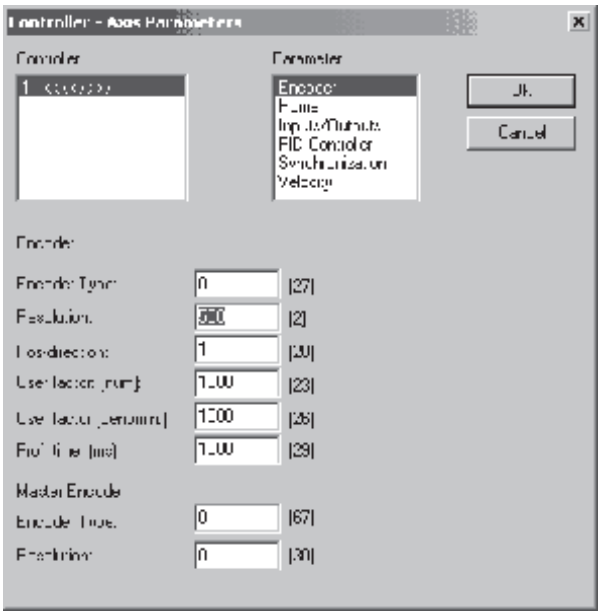
To be able to communicate with the SyncPos option please observe the application example regarding the wiring of the RS 232 to 485 converter.

Please note that outputs of both the VLT and SyncPos may change, hence control of mechanical brake or such may be interrupted.

Next, there are only 2 important parameters for testing the encoder connection and rotation. One is the Proportional gain factor of the SuncPos PID loop. This parameter is accessible via the LCP parameter 702. The other is the encoder resolution parameter (ENCODER). To access the ENCODER parameter click "CONTROLLER", "PARAMETERS", and "AXIS".

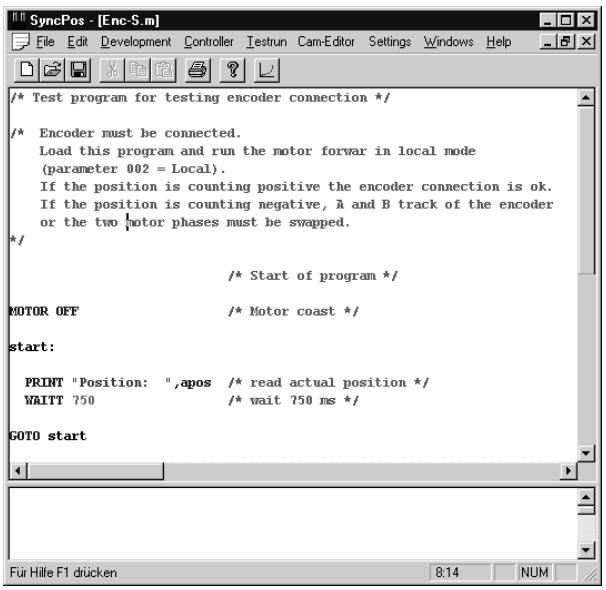


Press "ok" to confirm interruption of program. Choose parameter group Encoder. The factory default setting of encoder resolution is 500 as shown.



Enter the correct value in pulses per revolution and press ok.

Check the encoder connections by means of the encoder test program. In the menu bar click on "FILE" and "OPEN" the file **Enc-S.m**, which is the first test program for starting operation.


SyncPos - [Enc-S.m]
File Edit Development Controller Testrun Cam-Editor Settings Windows Help
/* Test program for testing encoder connection */
/* Encoder must be connected.
Load this program and run the motor forwar in local mode
(parameter 002 = Local).
If the position is counting positive the encoder connection is ok.
If the position is counting negative, A and B track of the encoder
or the two motor phases must be swapped.
*/
/* Start of program */
MOTOR OFF /* Motor coast */
start:
PRINT "Position: ",apos /* read actual position */
WAITT 750 /* wait 750 ms */
GOTO start
Für Hilfe F1 drücken
8:14
NUM

First set parameter 700 = "2". In the "DEVELOPMENT" menu click on "EXECUTE" in order to start the test program or press F5. The position 0 is registered in the communications window.Run the

drive forward for example in local mode (Parameter 002 = "Local") then the position must count positive. If the position is counting negative you must swap A and B channels from the encoder or two motor phases.

You can also turn the encoder by hand (the motor should not be connected!). The position is continuously registered in the communications window. For a full rotation you should receive 4 times the value of the resolution of the encoder, that means 2000 if the Encoder pulses per revolution is 500.

Ending the encoder check

End the test of the encoder with the [ESC] key and close the test program with "FILE" → "CLOSE". A successful test of the encoder is a requirement for further starting up of operations.

If the encoder doesn't work

This could be a result of incorrect cable installation. Measure the signals coming from the encoder and compare them to the values listed in the specifications. Check whether the connection was made according to the application.

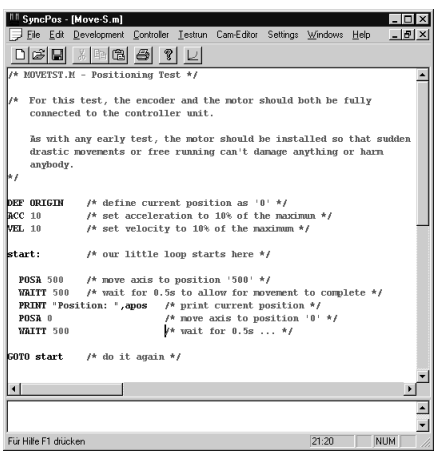
■ Execute the test run program

Now connect the motor to the VLT, make sure that the motor can turn completely freely.

NB!
The motor must be provided with an [EMERGENCY STOP] button.

NB!
Turn off the motor immediately with the EMERGENCY STOP button if it vibrates heavily or sets off uncontrolled.

Click on "FILE" and "OPEN" the file **Move-S.m**.


SyncPos - [Move-S.m]
File Edit Development Controller Testrun Cam-Editor Settings Windows Help
/* MOVETST.M - Positioning Test */
/* For this test, the encoder and the motor should both be fully connected to the controller unit.
As with any early test, the motor should be installed so that sudden drastic movements or free running can't damage anything or harm anybody.
*/
DEF ORIGIN /* define current position as '0' */
ACC 10 /* set acceleration to 10% of the maximun */
VEL 10 /* set velocity to 10% of the maximum */
start: /* our little loop starts here */
POSA 500 /* move axis to position '500' */
WAITT 500 /* wait for 0.5s to allow for movement to complete */
PRINT "Position: ",apos /* print current position */
POSA 0 /* move axis to position '0' */
WAITT 500 /* wait for 0.5s ... */
GOTO start /* do it again */
Für Hilfe F1 drücken
21:20
NUM

If the VLT parameter 002 is "LOCAL" please change it = "REMOTE". Click on "DEVELOPMENT" and start the test program with "EXECUTE" or [F5]. The test is successful if the motor runs slowly back and forth and position 500 is registered.
End the test with [ESC] and "CLOSE" the "FILE".

If the motor doesn't move

If the motor doesn't move at all, then the proportional factor of the PID filter is probably too low or the VLT has not been enabled. Another possibility is that the encoder resolution is high. Therefore we recommend to change line 17 "POSA500" to be half the encoder resolution in quadcounts. E.g. encoder ppr is 4096. Line 17 should be changed to (4096 x 4/2) "POSA 8192".
Check the VLT enable (terminal 27 = 24 V) and check that the VLT wasn't stopped via the LCP (flashing display). Then increase the ***Proportional factor*** (parameter 702). (See following chart).

Encoder ppr (ENCODER)	Proportional (KPROP) par 702
500	200
512	200
1000	100
1024	100
2000	50
2048	50
2500	50
3600	25
4096	25
5000	25

If the encoder is not mounted on the motor please note the gear-ratio between motor and encoder. Use this ratio to multiply the Proportional factor. E.g. motor turns 2 rev. encoder turns 1 rev. ratio is 1:2. Multiply the Proportional factor with 2.

If the motor vibrates heavily...

... then you have to: reduce the ***Proportional factor*** KPROP (11). If the drive stops due to a "O. Err. 8 in the LCP" then it is necessary to increase the ***Tolerated position error*** POSERR (15). (See 10 steps to optimise the PID loop).

■ Commissioning Guideline

When the APOS user program is written and it is time to impelment it in a given application it is a godd idea to have a plan of attack. Below is a list with 10 steps to success with SyncPos. It does not make sense to download the APOS user program and run the machine before the VLT and SyncPos parameters are correctly set. If something goes wrong during commissioning the troubleshooting guideline can be used to assist in the faultfinding.

1. Setup of VLT parameters (AMA)
2. SyncPos PC software installation and starting
3. Setup of serial communication
4. Setup of SyncPos parameters
5. Check encoder connection and direction of rotation
6. Execute testrun via SyncPos PC software
7. Optimise PID controller of SyncPos
8. Install software (APOS user program)
9. Test functionality of user program
10. SUCCESS

■ How the control process works

The "TESTRUN" explained in the chapter PC Software Interface of the SyncPos manual found on the CD can be used as a tool to optimize the SyncPos controller settings, thereby optimizing your system performance. To do that you only need to know a few things about the control scheme of SyncPos:

The SyncPos position controller has two parts:

1. The *Setpoint Generator* interprets the various positioning commands in SyncPos and generates a series of setpoint positions that eventually ends with the desired position.
   Normally, all positioning processes have a trapeze-shaped velocity curve. That means that after a phase of constant acceleration there is a phase with constant velocity and finally a phase with constant deceleration, which ends at the desired target position.
2. The *PID controller* receives the setpoint positions from the *Setpoint generator* and in turn calculates the speed reference needed for the motor to follow the current setpoint position.
   By setting the PID control parameters you can directly influence to what degree and ■ Significance and influence of the control parameters quickly a deviation from a theoretical set path (as specified by the setpoint series) should be counteracted.

The following behavior indicate that the control parameters are not optimally adjusted:

- Drive vibrates
- Drive is loud
- Frequent occurrence of position errors
- Poor control accuracy

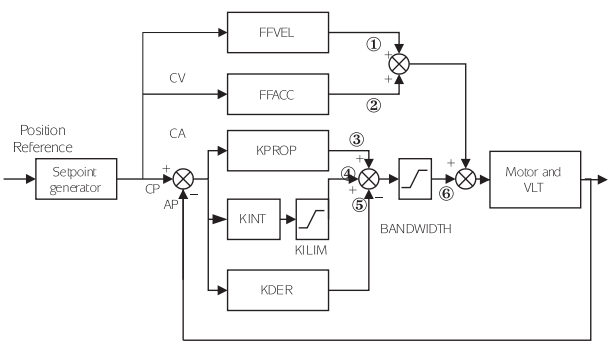
NB!
The control parameters are load-dependent. Thus the drive must be optimized under the actual conditions of use.
In exceptional cases it may be necessary to determine various sets of control parameters while working with heavily changing load conditions and to reprogram them in subsequent application programs depending on the motion process.

■ Significance and influence of the control parameters

The PID control unit of the SyncPos option transfers the necessary output frequency via an internal speed reference to the VLT. This set value is periodically re-calculated with an interval of one millisecond (interval is programmable by the TIMER parameter). The SyncPos option is by default set with soft 'fit for all' controller parameters.

The PID filter works according to the following formula:

① = FFVEL * (Setpoint velocity)
② = FFACC * (Setpoint acceleration)
③ = KPROP * (Position deviation)
④ = KINT * (Sum of all previous position deviations) (limited by KILIM)
⑤ = KDER * (Velocity of position deviation)
⑥ = ③ + ④ + ⑤
(limited by BANDWIDTH)



AV is the actual velocity
AP is the actual position (calculated from encoder feedback) in qc (Quad Counts).
CP is the current Setpoint position in qc.
CV is the Setpoint velocity in qc/ms.
(Position deviation) is calculated by CP–AP.

NB!
In SYNCV mode the PID controller is working with speed deviation instead of position deviation. Speed deviation is calculated by CV–AV.

The controller in the SyncPos card utilizes two control strategies at the same time:

1. An open-loop feed-forward control. Since the asynchronous motor inherently has a good open loop performance the feed-forward control is a very important part of the controller in most applications. Benefits from using feed-forwards control is a very fast and accurate response to changes in the s*etpoint reference.*
2. A closed-loop PID control. The PID controller monitors the difference between the actual position and the setpoint position. Based on this information it calculates a control signal to minimize the position deviance. Thus the SyncPos option is able to compensate for changes in load or friction. The PID controller is also necessary to compensate for any position deviance caused by inaccurate setting of the open-loop feed-forward controller.

In short: The feed-forward control is used to handle changes in the setpoint reference (especially important in synchronization applications), while the PID control is used to handle changes in load conditions or inaccuracies of the feed-forward control.

Proportional factor KPROP (11)

The ***Proportional factor*** is multiplied with the position deviance and the result is added to the control signal (the internal speed-reference to the VLT). Since the calculated control signal is proportional to the position deviance (or error) this kind of control is called proportional control. The behavior of the proportional control is similar to that of a spring – the further the spring is extended the stronger the counter-force it produces.

Influence of the ***Proportional factor****:*

KPROP too small	large position deviation due to non-compensatable load and frictional moment;
KPROP larger	quicker reaction, smaller steady-state deviation, larger overshoot, lesser damping;
KPROP too great	heavy vibrations, instability.

Derivative factor KDER (12)

The ***Derivative factor*** is multiplied with the derivative of the position deviance (the 'velocity' of the position deviance) and the result is added to the control signal. The behavior of the derivative control is similar to that of an absorber – the faster the absorber is extended the stronger the counter-force it produces. Thus using the ***Derivative factor*** increases damping in your system.

Influence of the ***Derivative factor****:*

KDER small	no effect;
KDER larger	better dampening, lesser overshoot; if KPROP is increased simultaneously: faster reaction to control deviation at the same level of vibration;
KDER too large	heavy vibrations, instability.

Integral factor KINT (13)

The sum of all error is calculated every time the control signal is updated. The ***Integral factor*** is then multiplied with the sum of all positioning errors and added to the overall control signal. Thus in case that steady-state position errors occurs in your application, make sure you use the integral part of the controller. Steady-state errors will be levelled out as the summed error increases over time until the control signal eventually matches the load.
It is possible to set a limit for the control signal generated by the integral part of the controller (anti-windup).

Influence of the ***Integral factor****:*

KINT very small	steady-state position deviance is very slowly regulated to zero;
KINT larger	faster regulation towards zero steady-state position deviance, larger overshoot;
KINT too large	heavy vibrations, instability.

Integration limit KILIM (21)

The ***Integration limit*** sets a limit for the control signal generated by the integral part of the controller. This helps to prevent the so called "wind-up" problems which typically occurs in applications where the overall control signal (the internal speed-reference) is maxed out for long periods of time.

This feature is also very helpful in applications where the power to the motor is turned off and on while the option card is controlling the VLT. Cutting of power to the motor (by setting terminal 27 low) while little positioning deviance is present in the controller, could result in an enormous control signal being generated once the power is turned back on.

Velocity Feed-forward FFVEL (36)

The ***Velocity feed-forward*** factor is a scaling factor that is multiplied with the derivative of the setpoint position (the velocity of the setpoint). The result of this operation is added to the overall control signal. This feature is especially useful in applications where there is a good correlation between the control signal (the VLT speed reference), and the speed of the motor. This is indeed the case with most applications using an asynchronous motor.

NB!
The scaling of the FFVEL parameter is dependent on the correct setting of the maximum reference (VLT parameter #205) as well as the SyncPos parameters VELMAX (1) and ENCODER (2).

Acceleration Feed-forward FFACC (37)

The ***Acceleration feed-forward factor*** is multiplied with the 2nd derivative of the setpoint position (the acceleration of the setpoint) and the result is added to the control signal. This feature should be used to compensate for the torque used to accelerate/ decelerate the system inertia.

NB!
Scaling of the FFACC factor is depending on the setting of the ***Shortest ramp time*** (31). You should therefore increase the FFACC accordingly when decreasing SyncPos parameter ***Shortest ramp time*** (31) and vice versa.

Sampling time for the entire control algorithm TIMER (14)

For particularly slow systems you can slow down the entire control system by entering multiples of 1 ms as the sampling time. However, it is important to remember that such a change influences all the control parameters!
Therefore, normally you should not deviate from the value of 1 ms.

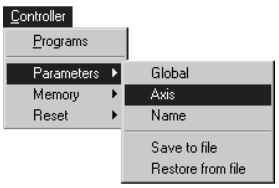
BANDWIDTH

A ***Bandwidth*** of 1000 means that the set value is being executed 100%, thus ***Derivative***, ***Proportional*** and ***Integral factors*** are effective as defined.

But if you are operating a system which could be jeopardized by vibrations, for example, a crane with a heavy load then you can limit the bandwidth in which the PID controller should function.
BANDWIDTH (35) of 300 makes a limitation of 30% possible. The build-up of a vibration is thus prevented since the control is only moved to with 30% of the calculated set value.
However, then it is necessary also to use the feed-forward part of the controller in order to achieve the corresponding control.

■ Optimizing your controller settings step-by-step

For best results use the functions in the **testrun** menu for this purpose; these help you to evaluate and optimize the PID controller on the basis of graphs of the set and actual curves.
However, we recommend only changing one value at a time and subsequently determining the improvement with a testrun**.**



Click on "CONTROLLER" → "PARAMETER" → "AXIS" and select the VLT, of which you are currently adjusting the settings.

Setting controller behavior

Before you adjust the controller parameters it is important to determine which controller behavior should be achieved.

NB!
The drive elements must never be operated outside of the technical specifications. Thus the maximum acceleration is determined by the "weakest" drive element.

- "Stiff" axis: the fastest reaction possible is mainly influenced by the ***Proportional factor***. You can judge the results on the basis of the velocity graph.
- Damping of vibrations are mainly influenced by the ***Derivative factor***. The results can best be assessed in the velocity graph.
- Temporary (static) deviations in position are mainly reduced by the ***Integral factor*** and can best be judged on the basis of the positioning graph.

Ten steps to optimise the PID loop

The following procedure will optimize your controller settings in most applications:

1. Make sure that you have specified correct values for VLT parameter #205, as well as the SyncPos parameters VELMAX (1), ENCODER (2) and RAMPMIN (31). If you change these settings again at a later point you may need to optimize the controller again.
2. Set the POSERR (15) parameter to a very high value e.g. 1000000 to avoid getting the option error no. 8 during the following tests.

   NB!
   To avoid damaging the system, make sure, that you set the POSERR within the limits of the system.
3. Optimize the ***Velocity feed-forward*** control:

   Auto feed-forward calculation:

   The FFVEL can be calculated hence it is not needed to perform a testrun to optimise the FFVEL. For VLT® 5000 process the following formula applies:

   FFVEL = (62914560000 * P104) / (Vnom * Eres * Tsample * P205)

   P104: Denotes the value of the VLT 5000 parameter 104 (nameplate motor frequency)
   P205: Denotes the value of the VLT 5000 parameter 205 (maximum reference)
   Vnom: Is the nominal encoder velocity at nominal motor frequency. The unit is RPM.
   Eres: Is the number of quad-counts per encoder revolution. If an absolute encoder is used the unit is steps (positions) per revolution.
   Tsample: Is the PID controller sampling interval (TIMER).

   For VLT® 5000 Flux the following formula applies:

   FFVEL = (62914560000 / Eres * Tsample * Vmax)

   Eres: Is the number of quad-counts per encoder revolution. If an absolute encoder is used the unit is steps (positions) per revolution.
   Tsample: Is the PID controller sampling interval (TIMER).

Vmax: Is the maximum encoder velocity. The unit is RPM. If the SyncPos feedback encoder is motor mounted then parameter 205 must be equal to Vmax.

FFVEL is now optimized, save the current value. Please note that some high inertia systems do not allow the use of FFVEL.

4. In systems with large inertia and/or rapid changes in the reference velocity it is a good idea to use and optimize the ***Acceleration feed-forward*** control (make sure the inertial load is connected when optimizing this parameter):
   Step 1)
   Execute a "TESTRUN" with KPROP=0, KDER=0, KINT=0, FFACC=0 and FFVEL at the optimized value calculated above. Use the highest possible acceleration setting. If RAMPMIN (31) is adjusted properly an acceleration value of 100 and a deceleration value of 100 should be sufficient. Start out with a low setting of FFACC approx. 10.
   Step 2)
   View the velocity profiles: If during acceleration the actual velocity is constantly lower than the reference velocity profile, then click "REPEAT" and set a higher value of FFACC. Then execute "TESTRUN" again.
   Step 3)
   Run successive TESTRUNs until the two velocity profiles shown in the TESTRUN graph have similar ramp-up and ramp-down curves.
   Step 4)
   FFACC is now optimized, save the current value.

5. Next step is finding the maximum stable value of the ***Proportional factor*** in the PID controller:
   Step 1)
   Execute a "TESTRUN" with KPROP (calculated FFVEL/50), KDER=0, KINT=0. Set FFVEL and FFACC at the optimized values found above.
   Step 2)
   View the velocity profile. If the velocity profile isn't oscillating then click "REPEAT" and increase KPROP else reduce KPROP and repeat.
   Step 3)
   Run successive TESTRUNs until the actual velocity profiles is oscillating mildly. Save this value.

6. In order to dampen the oscillations created by the KPROP-part of the controller, the ***Derivative factor*** should now be optimized.
   Step 1)
   Execute a "TESTRUN" with KINT=0 and KDER=5*KPROP. Set FFVEL, FFACC and KPROP at the optimized values found above.
   Step 2)
   Run successive TESTRUNs with increasing values of the KDER factor. At first the oscillations will gradually reduce. Stop increasing KDER when the oscillations begin to increase.
   Step 3)
   Save the last value of KDER.

7. In any system that requires a close to zero steady-state error, the integration part of the controller must be used. Setting this parameter though is a trade-off between achieving zero steady-state error fast and increasing overshoot and oscillations in the system.
8. If you are using the integration part of the PID controller, remember to reduce the KILIM as much as possible (without losing the KINT-effect of course) in order to reduce oscillations and overshoot as much as possible.
9. Reduce the BANDWIDTH only if the system has a tendency to vibrate. With a properly optimized open-loop control BANDWIDTH could be reduced to as little as 6 to 12 %.
10. Set the POSERR (15) parameter back to normal e.g. 20000.

"TEST PARAMETER" → "SAVE"

Once you have concluded the "TESTRUN" → "SAVE" the new parameters as the user parameters. Thus, these parameters are saved in the controller and in the future will be used for all programs.

■ What to do if...

... there is a tendency towards instability

In the event of a strong tendency towards instability reduce the proportional and derivative factors again, or reset the integral factor.

... stationary precision is required

If stationary precision is required then you must increase the integral factor.

... the tolerated position error is exceeded

If the test run is constantly interrupted with the message “position error” set the parameter for the *Tolerated position error* POSERR (15) – within the tolerable limits– as large as possible.
If the position error occur during the acceleration phase that suggests that the set acceleration cannot be achieved under the existing load conditions. Increase the *Tolerated position error* POSERR (15) or determine a maximum acceleration suitable for the entire system.
If position error do not occur until after the acceleration phase and they can be delayed but not eliminated by increasing the *Tolerated position error,* this suggests that the maximum velocity (rpm) chosen is too high. Determine a maximum velocity suitable for the entire system.

.. the maximum acceleration is not achieved

In general, the technical data for a drive are only valid for a freely rotating axle end. If the drive is carrying a load the maximum acceleration is reduced. The theoretical maximum acceleration will also not be achieved if, for example, the PID controller output is too small or the VLT/motor is not sized correctly and therefore does not provide enough energy for peak consumption during acceleration.

■ VLT and SyncPos Motion Controller messages

All messages are shown in the LCP display of the VLT in short and in the SyncPos software in plain text.

You can find brief information on the error messages in the table or detailed information in the following section.

■ Table of Messages

The tables contain the messages in numerical order. Letters following a % sign represent variables which can be used in plain text at the corresponding locations.

O.ERR_	LCP-Display	SyncPos message
3	AXES NOT IN SYSTEM	Axis no. *%bu* not in system
5	ERROR NOT CLEARED	Axis no: 1 Error not cleared
6	HOME NOT EXECUTED	Axis no: 1 Failed to move to HOME position
7	HOME_VEL ZERO	Axis no: 1 Home vel 0
8	POSITION ERROR	Axis no: 1 Position error
9	INDEX NOT FOUND	Axis no: 1 Index pulse (encoder) not found
10	UNKNOWN COMMAND	Unknown command
11	SOFTWARE LIMIT ACT.	Axis no.1 Software limit switch activated
12	ILLEGAL PARAMET. NO	Illegal parameter number
13	General VLT error	General VLT error
14	TOO MANY NEST. LOOP	Too many nested loops
16	PARAM. ERROR EEPROM	Parameters in EEPROM are corrupted
17	PROGR. ERROR EEPROM	Programs in EEPROM are corrupted
18	RESET BY CPU	Reset by CPU
19	USER ABORT	User abort
25	LIMIT SWITCH ACTIV.	Axis no. 1 Limit switch activated
49	TOO MANY INTERRUPTS	Too many interrupt functions
51	TOO MANY NEST. GOSUB	Too many nested GOSUB commands
52	TOO MANY RETURN	Too many RETURN commands
62	ERROR IN VERIFYING	EEPROM: address % defect
70	ERROR IN DIM COMMD	Error in DIM command
71	ARRAYBOUNDS CROSSED	Attempt was made to cross arraybounds
79	TIMEOUT WAITNDX	Timeout while waiting for index
84	TOO MANY ONTIME	Too many time interrupts
87	OUT OF MEMORY (VAR)	No more room for variables
90	MEMORY locked	The program memory is write-protected.
91	ILLEGAL CURVE ARRAY	Curve array wrong
92	ENCODER ERROR	Error from encoder monitoring
xx	INTERNAL ERROR	Internal error ##

■ SyncPos option messages in detail

As in the table above, the messages are in numerical order. Here you can find additional information about possible causes and tips on troubleshooting.

O.ERR_3

SyncPos

Axis no. *%bu* not in system

Cause

An attempt has been made to find another axis which does not exist in the controller. (The program allows for input of axis numbers greater than 1 since it is configured for multi-axes applications.)

Tip

Check to see if the program axis command has an invalid number or a general axis command (...X(*)).

O.ERR_5

SyncPos

Axis no: 1 - Error not cleared

Cause

An attempt has been made to execute a motion command, although a momentary error message has not been cleared.

O.ERR_6

SyncPos

Axis no: 1 - Failed to move to HOME position

Cause

According to the axis parameter HOME_FORCE (3), a forced move to the machine zero-point is demanded, before other motion commands can be executed. This move to the machine zero-point has not been executed.

O.ERR_7

SyncPos

Axis no: 1 - Home vel 0

Cause

HOME was executed with HOME_VEL set to zero.

O.ERR_8

SyncPos

Axis no: 1 - Position error

Meaning

The distance between the set and the real position was greater than the ***Tolerated position error*** defined in parameter POSERR (15).

Cause

Mechanically blocked or overloaded drive,
Tolerated position error POSERR (15) too small,
commanded speed greater than VLT Parameter 202 and 205,
commanded acceleration too great,
Proportional factor KPROP (11) too small or
VLT not enabled.

O.ERR_9

SyncPos

Axis no: 1 - Index pulse (encoder) not found

Meaning

At reference resp. index search, the encoder index pulse could not be found within a motor rotation.

Cause

An encoder without an index pulse has been used,
index pulse not connected correct,
index pulse incorrect (all three channels must have a simultaneous low) or
the parameter ENCODER (2) is set too low.

O.ERR_10

SyncPos

Unknown command

Cause

A communication or program error.

Tip

The program must be re-compiled and re-loaded.

O.ERR_11

SyncPos

Axis no. 1 Software limit switch activated

Cause

A motion command will cause / has caused the software limit switch to be activated.

Tip

Identification of attainment of software limit at a motion in the speed mode will only be made after the current position is identical to the software limit switch.
The control unit will be switched off and the drive must be manually moved back to within the admissible area, or the monitoring of the software limit switch must be temporarily de-activated via the axis parameter SWPOSLIMACT (20) resp. SWNEGLIMACT (19). Only then is it possible to clear the error.
In positioning mode, it will be known before motion start that the target position lies outside the path. In this case, the movement will not be executed and the error message can be cleared.

O.ERR_12

SyncPos

Illegal parameter number

Cause

An attempt has been made to change a parameter (SET or SETVLT command), which does not exist.

O.ERR_13

SyncPos

General VLT error

Cause

Every 20 ms the VLT status is tested and in the event of an error status this fault alarm is given. Bits with the value of 512 and 2048 are checked. This test only takes place in the controlled status, not at MOTOR OFF and not when parameter 700 is deactivated.

Note

You can enquire in the VLT status as to the exact cause of the fault alarm (e.g. „Trip“ or „Not ready“).

O.ERR_14

SyncPos

Too many nested loops

Cause

Too many nested loops exist in the executed program.

O.ERR_16

SyncPos

Parameters in EEPROM are corrupted

Meaning

The parameters in EEPROM are no longer correct.

Cause

EEPROM defective or
power outage while saving.

Tip

You have to re-initialize the parameter with "CONTROLLER" → "PARAMETERS" → "RESET" and then overwrite these parameters with your own user parameters. Otherwise motion programs which require user parameters will no longer function correctly.

O.ERR_17

SyncPos

Programs in EEPROM are corrupted

Meaning

The program data stored in EEPROM cannot be found resp. are no longer correct.

Cause

EEPROM defective or
power outage while saving.

Tip

Delete the EEPROM with "CONTROLLER" → "MEMORY" → "DELETE EEPROM" and then re-load the programs and parameters.

O.ERR_18

SyncPos

Reset by CPU

Meaning

The processor has been stopped and a re-set has automatically been executed (watchdog).

Cause

Short term voltage drop,
voltage peak or
short circuit.

O.ERR_19

SyncPos

User-Abort

Cause

The autostart-program has been aborted by the user.
Or the [CANCEL] key was pressed during switching on and a Master Reset triggered.

O.ERR_25

SyncPos

Axis 1: Limit switch activated

Cause

A motion command has caused an axis limit switch to be activated.

Tip

Through activation of a limit switch, the controller – depending on the parameter ENDSWMOD (44) – is automatically switched off and the drive must be manually moved out of this position, before the error message can be cleared.

O.ERR_49

SyncPos

Too many interrupt functions

Cause

More interrupt functions than the maximum possible number were used …

Tip

…permitted are:
32 ON INT
32 ON STATBIT
32 ON COMBIT
10 ON PARAM
20 ON APOS, ON MAPOS, ON MCPOS

O.ERR_51

SyncPos

Too many nested GOSUB commands

Cause

In the program, too many calls from one subroutine to another subroutine exist.
The error usually occurs when there is a recurrent reference to one of the sub-programs in a sub-program.

Tip

Avoid too many (10 is maximum) opposing subroutine calls,
avoid subroutines which call themselves (re cursive subroutine procedures).

O.ERR_52

SyncPos

Too many RETURN commands

Cause

There are either more RETURN than corresponding GOSUB commands in the program, or there is a direct jump from a subroutine with a GOTO command.
Only one RETURN is allowed per sub-program.
It is always better to jump to the beginning of a sub-program and then to jump with IF… to a previously defined label.

O.ERR_62

SyncPos

Error in verifying

Meaning

After saving something in the EEPROM (a program or parameters) an error was detected during verification.

Tip

Delete the EEPROM with "CONTROLLER" → "MEMORY" → "DELETE EEPROM" and try to save the program or parameters again. If this is not successful please call the technical service department.

O.ERR_70

SyncPos

Error in DIM command

Meaning

The definition of an array in a DIM command does not correspond to an already existing array in the SyncPos option.

Cause

The fields are from older SyncPos programs. The current program has other definitions.

Tip

Either adapt the SyncPos program to the correct array size or delete the old arrays with "CONTROLLER" → "MEMORY" → "DELETE EEPROM".

NB!
Remember to follow the recommendations concerning saving programs and parameters before deleting the EEPROM.

O.ERR_71

SyncPos

Attempt was made to cross arraybounds

Meaning

An attempt was made to describe an array element that is located outside of the defined array limits.

Cause

Error in the SyncPos program. Array sizing does not agree with the space required (e.g. due to an incorrectly programmed loop).
Or the array is too small for the number of test runs triggered by TESTSTART.

Tip

Check loop variables.

O.ERR_79

SyncPos

Timeout while waiting for index.

Meaning

The command WAITNDX was executed and the timeout listed was exceeded.

Cause

The timeout is probably too short or the index impulse could not found (see also O.ERR_9).

O.ERR_84

SyncPos

Too many time interrupts

Meaning

Too many ON TIME or ON PERIOD commands were used within the program.

Tip

A maximum of 12 of these ON TIME and/or ON PERIOD commands are allowed within one program**.**

O.ERR_87

SyncPos

No more space for variables

Meaning

When the SyncPos program is started the space for the necessary variables is reserved dynamically. This space is now no longer available.

Cause and tip

You may have selected a maximum number of variables which is too high. Reduce the maximum number in "SETTINGS" → "COMPILER" (Standard = 92).
Or the memory available is occupied with programs or arrays. Delete the programs with "CONTROLLER" → "PROGRAMS" → "DELETE ALL"
or delete both the programs and arrays, i.e. by deleting the entire memory with "CONTROLLER" → "MEMORY" → "DELETE EEPROM"**.**

NB!
Remember to follow the recommendations concerning saving programs and parameters before deleting the EEPROM.

O.ERR_90

SyncPos

MEMORY locked

Meaning

The program memory is write-protected and cannot be altered.

Tip

This means that autorecognition can neither be set nor deleted and programs can neither be saved or deleted. Equally, → "RAM SAVE" and → "EEPROM DELETE" will not be executed.

O.ERR_91

SyncPos

Curve array wrong

Meaning

An incorrect or old array is defined in the DIM instruction for SETCURVE.

Tip

An old array may exist if the cnf file with all parameters and arrays has not been loaded into the CAM-Editor.
An incorrect array could be caused by the following:

- It was not created by the curve editor.
- Previous version of a curve editor. Such an array must first be converted by the current curve editor (→ "LOAD" and "SAVE").
- Or the order of the arrays in the DIM instruction does not match the order in the cnf file. Refer to the number of the array in the title bar of the CAM-Editor in this respect.

O.ERR_92

SyncPos

Error from encoder monitoring

Meaning

Open or short circuit in accordance with the displayed LED

NB!
An error will be indicated even if no encoder is connected.

O.ERR_xx

SyncPos

Internal error ##

Meaning

If such an error should occur, please contact your dealer and report the error number displayed to the technical service department.

■ VLT software SyncPos messages

The VLT software SyncPos messages are arranged in alphabetical order. Letters following a % sign represent variables which can be used in plain text at the corresponding locations.

■ Compilation error ...

SyncPos

Compilation error(s): program not saved!

Meaning and tip

A file is always compiled first and then saved. If you want to save the program, for example in the menu "CONTROLLER“ → "SAVE PROGRAM" and a syntax error is found during compilation this message will be displayed.
Start the “SYNTAX CHECK” in the menu “DEVELOPMENT”, correct the syntax error and then save the program.

■ Connection to ... already exists ...

SyncPos

Connection to %d already exists [%s] - change to new Window?

Meaning

When opening a new window or when trying to connect a window with a controller that is already linked to a window.

Yes The controller is disconnected from the old window and linked to the new window.

No The controller stays connected to the old window, the new window is not linked to a controller.

■ Controller is executing a program ...

SyncPos

Controller is executing a program or command!

Meaning

When the controller is executing a command or program it is not available for additional commands. You have to → "BREAK" the new command and restart it once the previous command has been completely executed.

■ **Error in array ...**

SyncPos

Error in array part of file.

Meaning

When re-saving a configuration ("CONTROLLER" → "PARAMETERS" → "RESTORE FROM FILE") the computer recognizes that the data in the array area is formatted incorrectly.

Cause

In order to be able to save a file, the following conditions must be fulfilled:

- Identical software versions
- same configuration (e.g. same number of axes)
- In the case that arrays have already been inputted, these must match the ones that are to be saved in terms of type and size.

■ **Error in axis parameter ...**

SyncPos

Error in axis parameter part of file.

Meaning

When re-saving a configuration ("CONTROLLER" → "PARAMETERS" → "RESTORE FROM FILE") the computer recognizes that the data in the area of the axis parameters is formatted incorrectly. The parameter number and the sequence must be correct and numbering must be continuous.

Cause

In order to be able to save a file, the following conditions must be fulfilled:

- Identical software versions, that provides same number and order of the parameters
- same configuration (e.g. same number of axes)

■ **Error in global parameter ...**

SyncPos

Error in global parameter part of file.

Meaning

When re-saving a configuration ("CONTROLLER" → "PARAMETERS" → "RESTORE FROM FILE") the computer recognizes that the data in the area of the global parameters is formatted incorrectly.

Causes

In order to be able to save a file, the following conditions must be fulfilled:

- Identical software versions, that provides same number and order of the parameters
- same configuration (e.g. same number of axes)

■ **Lost connection to ...**

SyncPos

Lost connection to #%d!

Meaning

If the VLT is turned off or the plug is pulled, etc. the window is disconnected from the VLT and the lost connection is registered.

■ **Timeout: no reply from VLT**

SyncPos

Timeout: no reply from VLT

Meaning

The VLT does not answer; check the connection.

There are two interfaces to the SyncPos option:

- 36 terminals on the option card
- 24 terminals on the VLT control card

■ VLT control card terminals

The terminals on the control card can be allocated for synchronizing and positioning functions if the following parameter settings are made:

Digital inputs 16, 17, 18, 19, 27, 29, 32 and 33:

It is always possible to read the status of the digital inputs from the SyncPos application program with the IN command.
If Parameter 300–303 and 305–307 are set to "No operation" (default setting) then the inputs are ignored by the control card but they can still be used as inputs to the application program.
Parameter 304 can not be set to "No operation" which means that input 27 always has a stop function. There is one way to avoid this: Leave parameter 304 at "Coast inverse" and select "Serial port" in parameter 502.

Analogue inputs 53, 54 and 60:

It is always possible to read the value on the analogue inputs from the SyncPos application program with the INAD command.
If parameters 308, 311 and 314 are set to "No operation" then the inputs are ignored by the control card but they can still be used as inputs to the option card.

VLT5000: Digital/analogue outputs 42 and 45:

Outputs 42 and 45 can be controlled from the SyncPos application program with the OUTDA command, when parameters 319 and 321 are set to one of the following four settings:

OPTION DIGITAL	[90]	digital output
OPTION 0 … 20 mA	[91]	analogue output (default setting)
OPTION 4 … 20 mA	[92]	analogue output
OPTION 0 … 32000P	[93]	pulse output

VLT5000Flux: Digital/pulse outputs 26 and 46

The outputs 26 and 46 on the VLT5000Flux control card can be controlled from the SyncPos application program with the OUTDA command when parameters 341 and 355 are set to one of the following settings:

OPTION DIGITAL	[90]	digital output
OPTION 0…50000P	[91]	pulse output

VLT5000Flux: Analogue outputs 42 and 45

The outputs 42 and 45 on the VLT5000Flux control card can be controlled from the SyncPos application program with the OUTDA command when parameters 319 + 321 are set to one of the following settings:

OPTION 0 … 20 mA	[90]	analogue output 0…20mA
OPTION 4 … 20 mA	[91]	analogue output 4…20mA

Relay outputs 01 and 04:

The relay outputs can be controlled from the SyncPos application program with the OUT command when parameters 323 and 326 are set to the default setting

CTRL WORD BIT 11/12

Technical data

Technical data on the control card terminals can be found in the VLT 5000 design guide.

■ Option card terminals

There are two encoder interfaces which are covering the following functions:

- Feedback encoder input
- Master encoder input / virtual master output

There are 8 digital inputs, 8 digital output and terminals for 5 V and 24 V supply. The functions and technical data of the terminals are described in the following.

Terminal description

There are 4 terminal blocks, 2 with 10 poles and 2 with 8 poles. *(See figure below)*

MK3A Digital Inputs

I1	I2	I3	I4	I5	I6	I7	I8	24 V	COM

MK3B Master / Virtual Master

5 V	COM	A1	$\overline{A1}$	B1	$\overline{B1}$	Z1	$\overline{Z1}$

MK3C Digital Outputs

O1	O2	O3	O4	O5	O6	O7	O8	24 V	COM

MK3D Feedback

5 V	COM	A2	$\overline{A2}$	B2	$\overline{B2}$	Z2	$\overline{Z2}$

Digital inputs

MK3A is a 10pole terminal block with 8 digital inputs (I1–I8) and 2 terminals for 24 V supply.
The digital inputs are used by the SyncPos application program and are therefore free programable. All the inputs can also be assigned functions:

Digital outputs

MK3C is a 10pole terminal block with 8 digital outputs and 2 terminals for 24 V supply.
The digital outputs are controlled by the SyncPos application program and are thus free programable. All the outputs can also be assigned functions.

Encoder interface 1

MK3B is a 8pole terminal block with 6 terminals for the encoder signals and 2 terminals with 5 V supply.
Encoder interface 1 can be used for one of the following 2 functions:

- Master encoder input (incremental or absolute) for synchronizing.
- Virtual master encoder output (incremental).

The table below shows the function of each terminal in the 3 possible modes. (*See fig. 1*)

NB!
When using the virtual master function termination must be switched off (sw 1.3) in all options except on the first and the last station connected in the network.

Encoder interface 2

MK3D is a 8pole terminal block with 6 terminals for the encoder signals and 2 terminals with 5 V supply.

Encoder interface 2 can be used for one of the following 2 functions:

- Slave encoder input (incremental or absolute) for synchronizing.
- Feedback encoder input (incremental or absolute) for positioning.

The table below shows the function of each terminal in the 2 possible modes. (*See fig. 2)*

Terminal	A1	$\overline{A1}$	B1	$\overline{B1}$	Z1	$\overline{Z1}$
Incremental input	A in	$\overline{A\ in}$	B in	$\overline{B\ in}$	Z in	$\overline{Z\ in}$
Absolute input	Clk out	$\overline{Clk\ out}$	Data in	$\overline{Data\ in}$	Not used	Not used
Virtual master	A out	$\overline{A\ out}$	B out	$\overline{B\ out}$	Z out	$\overline{Z\ out}$

Fig. 1

Terminal	A2	$\overline{A2}$	B2	$\overline{B2}$	Z2	$\overline{Z2}$
Incremental input	A in	$\overline{A\ in}$	B in	$\overline{B\ in}$	Z in	$\overline{Z\ in}$
Absolute input	Clk out	$\overline{Clk\ out}$	Data in	$\overline{Data\ in}$	Not used	Not used

Fig. 2

■ Technical data

Terminals:

Type ..... Plugs with screw connections
Maximum cable size ..... 1.3 mm^2 (AWG 16)

Digital inputs, MK3A:

Number of inputs which are used by SyncPos program 8
Terminal designations ..... I1 – I8
Voltage level ..... 0 – 24 V DC (PNP positive logic)
Voltage threshold logical "0" ..... 5 V DC
Voltage threshold logical "1" ..... 10 V DC
Maximum voltage ..... 28 V DC
Input impedance ..... 4 kΩ
Min. pulse duration (ON INT) ..... 1 msec
Galvanic isolation: All digital inputs are galvanically isolated by means of optocouplers, but with the same common as the digital outputs.

Digital outputs, MK3C:

Number of outputs which are used by SyncPos program 8
Terminal designations ..... O1 – O8
Voltage level ..... 0 – 24 V DC
Maximum load ..... 0.7A (with external power supply)
Update rate ..... 1 msec
Galvanic isolation: All digital outputs are galvanically isolated by means of optocouplers, but with the same common as the digital inputs.

External 24 V DC supply:

(see VLT 5000 manual)

Encoder input 1, MK3B (master):

Terminal designations ..... A1, ~~A1~~, B1, ~~B1~~, Z1, ~~Z1~~.
Incremental:
Signal level ..... 5 V differential
Signal type ..... Linedriver, RS 422
Input impedance ..... 120 Ω (Dip switch 1.3 = ON)
..... > 24 kΩ (Dip switch 1.3 = OFF)
Maximum frequency ..... 220 kHz (at 50 % duty cycle)
Phase displacement between A and B ..... 90° ±30°
Absolute:
Signal level ..... 5 V differential
Signal type ..... SSI
Data coding ..... Gray code
Data length ..... 25 bit
Parity ..... none
Clock frequency ..... 105 or 260 kHz
Protocol ..... Gray
Maximum positions per revolution 8192
Maximum number of revolutions 4096

Encoder input 2, MK3D (slave):

Terminal designations ..... A2, ~~A2,~~ B2, ~~B2,~~ Z2, ~~Z2,~~
Incremental:
Signal level ..... 5 V differential
Signal type ..... Linedriver, RS422
Input impedance ..... 120 Ω
Maximum frequency ..... 220 kHz (at 50 % duty cycle)
Phase displacement between A and B ..... 90° ±30°
Absolute:
Signal level ..... 5 V differential
Signal type ..... SSI
Protocol ..... Gray code
Data length ..... 25 bit
Parity ..... none
Clock frequency ..... 105 or 260 kHz
Maximum positions per revolution 8192
Maximum number of revolutions 4096

Encoder cable:

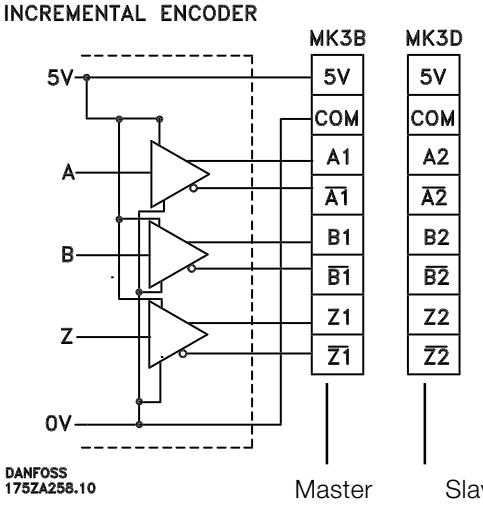
Cable type ..... Twisted pair and screened. **Note:** Please observe the prescriptions of the encoder supplier
Cable length ..... Observe the prescriptions of the encoder supplier.
Absolute encoder is tested ok up to 150 meter cable at 105 kHz clock and 100 m at 262 kHz clock.
*(Tested with TR electronic encoder type CE-65 M 8192*4096 and appropriate cable prescribed by TR electronic.)*
Maximum allowed time delay between clock and data signal measured at the controller terminals .....
..... 105 kHz clock = 9µsec
..... 262 kHz clock = 3.5 µsec

Encoder output, MK3B:

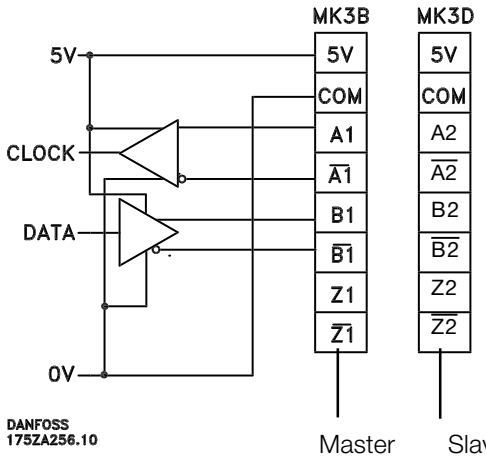
Terminal designations ..... A1, ~~A1,~~ B1, ~~B1,~~ Z1, ~~Z1,~~
Signal type ..... Linedriver, RS485
Maximum frequency ..... 150 kHz
Minimum frequency ..... 150 Hz
Maximum number of slaves ..... 31 (more when using repeaters)
Maximum cable length ..... 400 m

■ Connection examples

INCREMENTAL ENCODER



ABSOLUTE ENCODER



■ Supply voltages:

The option card is supplied by the internal 24 V DC supply of VLT 5000, but as the available power is limited it can be necessary to use an external 24 V DC supply.

The 24 V DC supply of VLT 5000 can supply a total of 420 mA including the load on the control card (terminal 12, 13 and output 42 and 45).

The 5 V output on the option card is generated from the 24 V supply. The maximum power on the 5 V side is 5 V * 280 mA = 1.4 W, this corresponds to app. 60 mA on the 24 V side.

When an external 24 V DC voltage source is used the internal 24 V supply from the control card must be disconnected, this is done by opening switch 1.1 and 1.2

Each digital input on the option card takes 8 mA.

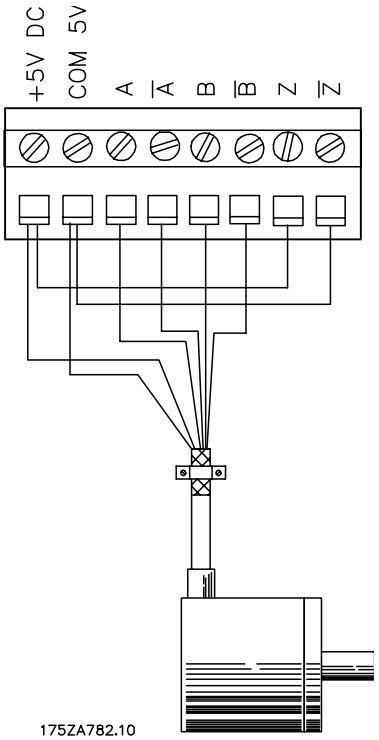
Each digital output on the option card can supply up to 0.7 A (external 24V-supply) depending on the load.

The load from the 24 V supply (internal or external) can be calculated as follows:

8 mA * number of digital inputs
+
Load on digital outputs
(mk3 C, O1 – O8)
+
load on 5 V supply
(mk3 B/D, 5 V/com)
+
Load on control card
(24 V supply, terminal 12/13 and outputs, terminal 42/45)

■ Encoder monitor

Both encoder interfaces are equipped with a monitoring circuit that can detect open circuit as well as short circuit of each encoder channel. Each encoder channel has a LED showing the status: Green light means ok, no light means fault. Zero channel monitoring can be switched off by means of switch 1.4, this is necessary when using incremental encoders without Zero channel or absolute encoders. Switch 1.4 disables monitoring of both master and slave Zero channel. If disabling of only one of the two Zero channels is required (e.g. when using incremental master encoder and absolute slave encoder) the unused Zero channel input must be connected to 5V/common as shown below.



An encoder fault will only result in an ”Option error” calling the error handler (ON ERROR) if encoder monitoring is activated via parameter MENCODER (master) and ENCODER (slave).

Note: Monitoring of the master encoder is disabled when switch 1.3 is ”OFF”.

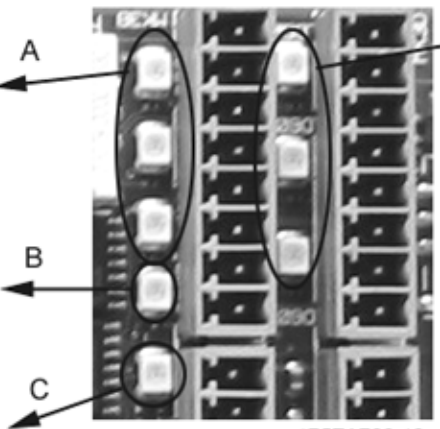
■ Option card layout:

Option card layout showing the position of connectors and dip switch.

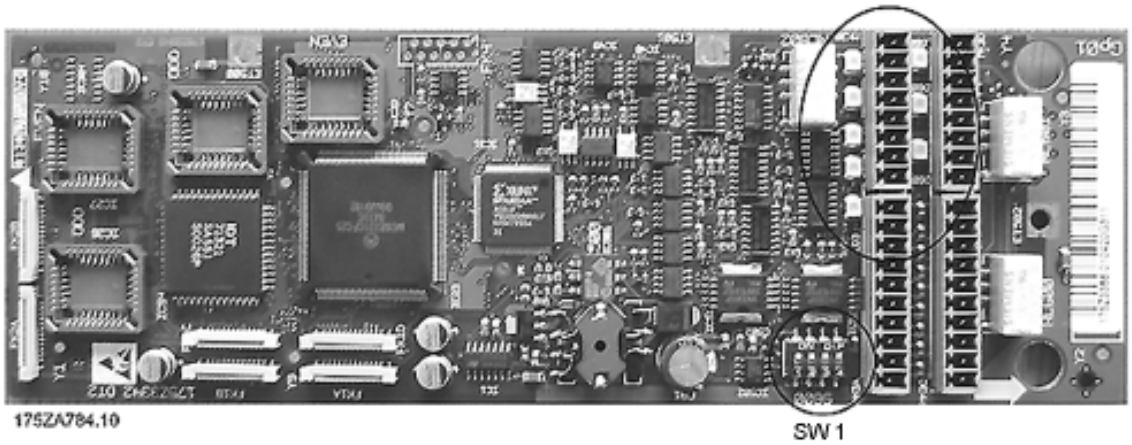
Encoder monitor master, channel A, B and Z:
LED off = Short or open circuit
LED green = Ok.

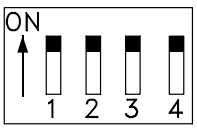
5V monitor:
LED off = no 5V
LED Green = 5V ok.

CPU monitor:
LED must flash at 1 Hz to indicate a running CPU system



Encoder monitor slave, channel A, B and Z:
LED off = Short or open circuit
LED green = Ok.

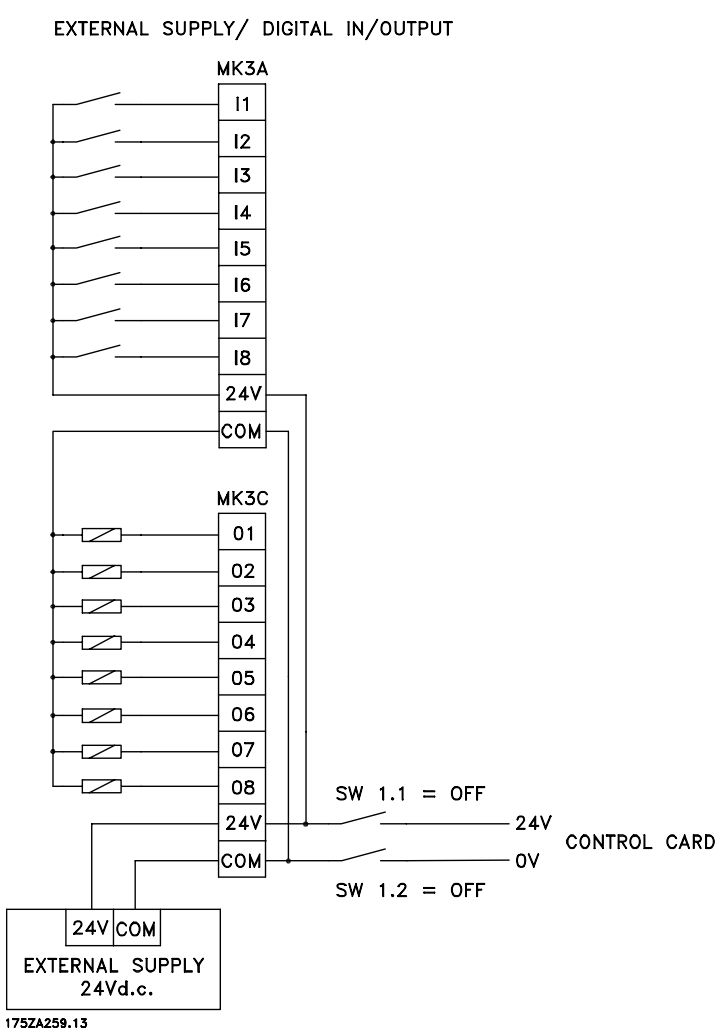


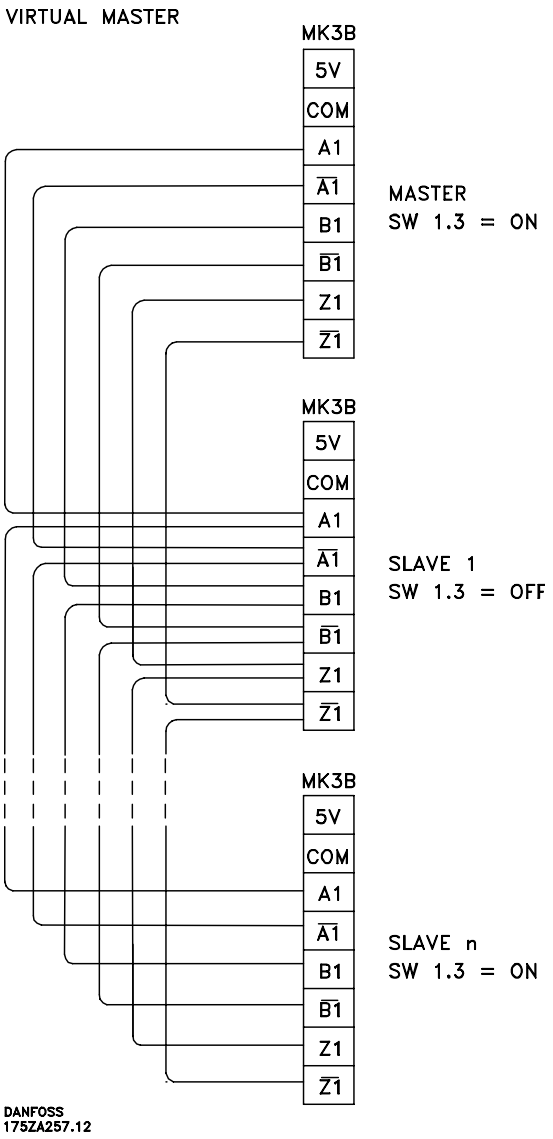


DANFOSS
175ZA068.10

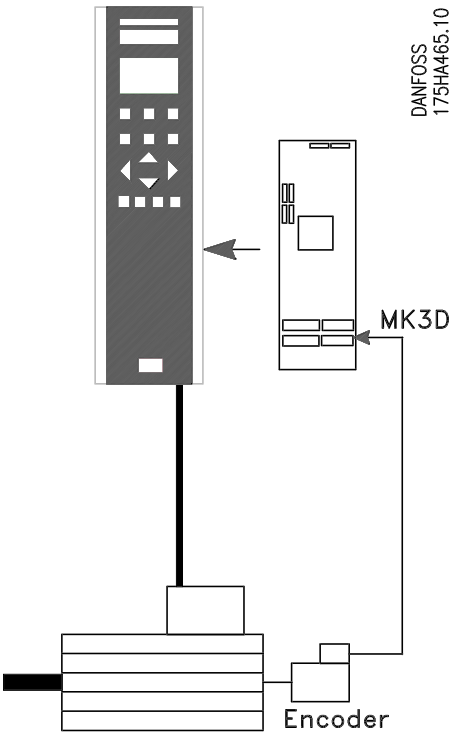
SW 1.1: Connect(ON)/disconnect(OFF) 24 V from control card (see description of supply voltages).
SW 1.2: Connect(ON)/disconnect(OFF) 24 V common from control card.
SW 1.3: Connect(ON)/disconnect(OFF) termination resistor for master encoder (see description of virtual master function).
Note: When OFF the master encoder monitor is disabled.
SW 1.4: Switch Z-channel encoder monitor ON/OFF for both master and slave.

Default setting of switch 1.1. - 1.4 is ON.



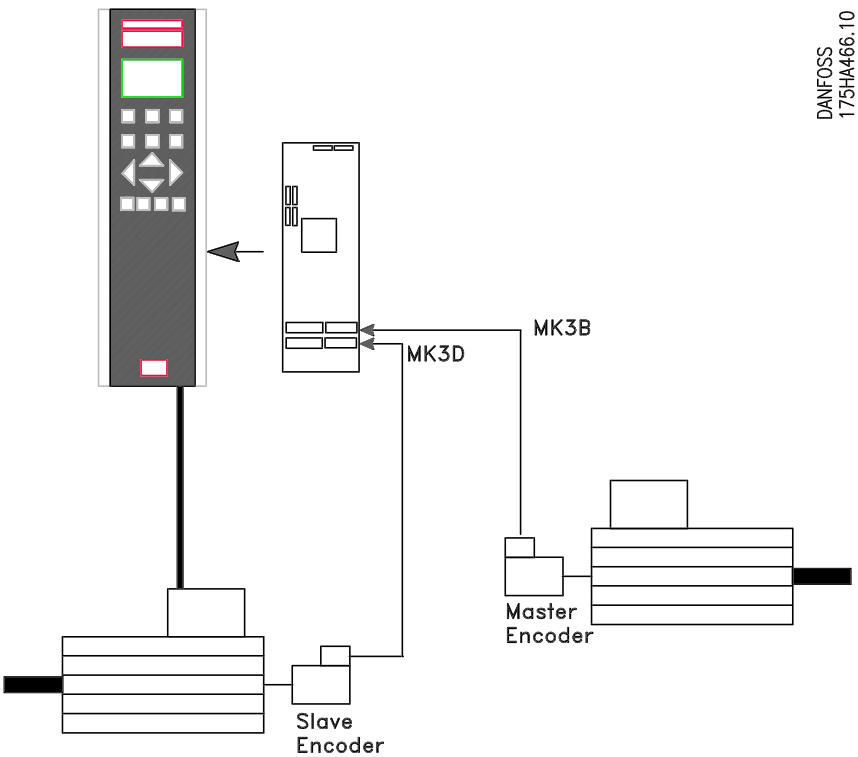


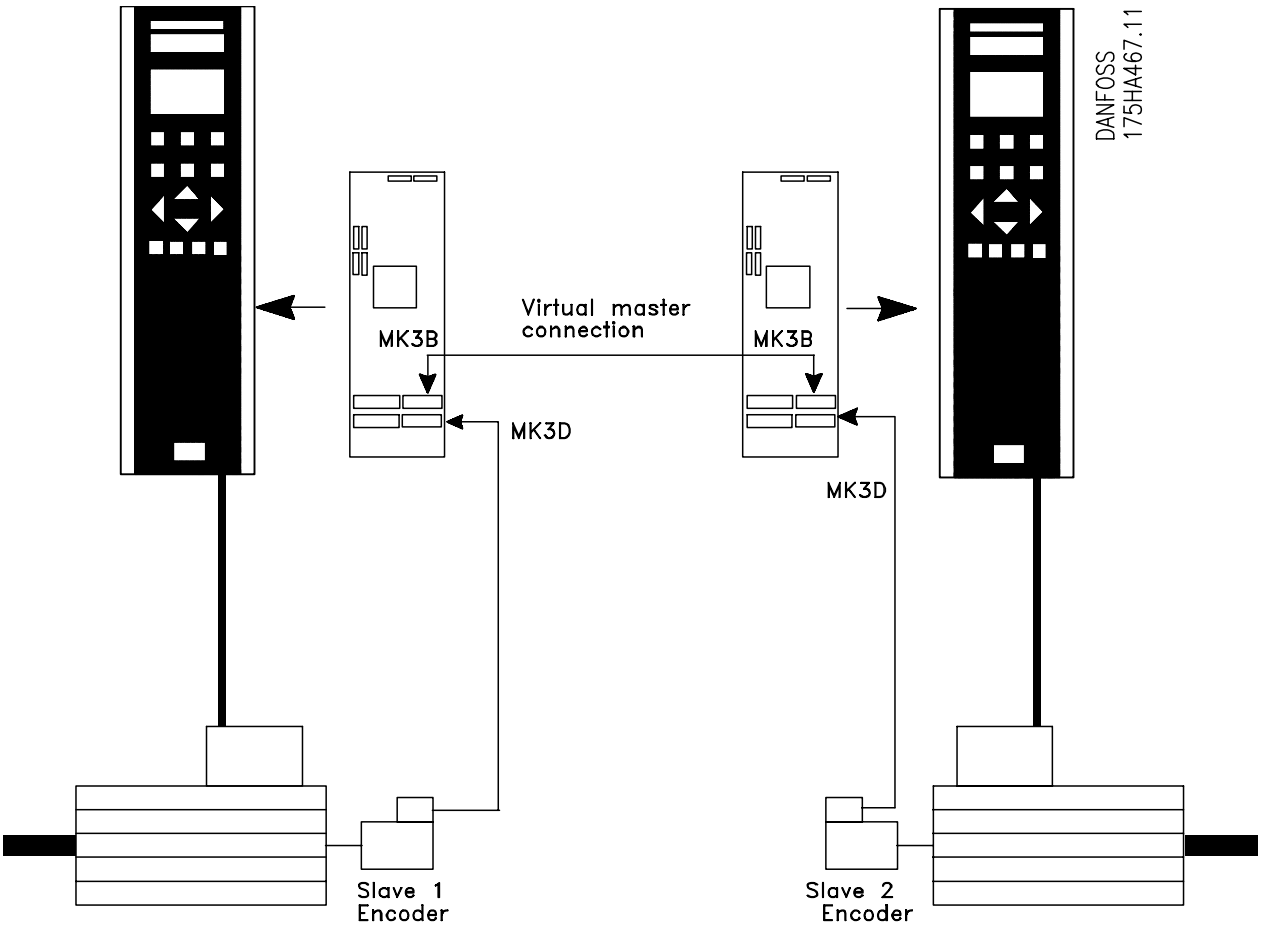
The terminating resistors on both end of the bus have to be switch on with dip switch SW 1.3.



left: encoder connection for positioning applications

below: encoder connection for master-/slave synchronization





Encoder connections for the synchronizing with virtual master.

■ Index

A

About this manual 3
Acceleration feed-forward FFACC (37) 13
APOS 4, 8, 11

B

BANDWIDTH (35) 11, 13, 15

C

CAM-Editor 7
Connection examples 27

D

Derivative factor KDER (12) 12, 14, 15
Digital inputs 25, 26
Digital outputs 25, 26
DIM 17, 21, 22

E

Encoder
  Connection check 9
ENCODER (2) 13, 14, 18
Encoder monitor 28, 29
ENDSWMOD (44) 20
ERRCLR 8
External 24 V DC supply 26

F

Factory settings 6
  Axis parameters 17
Feed-forward Acceleration FFACC (37) 13
FFACC (37) 11, 13, 15
FFVEL (36) 13

G

GOSUB 17, 20
GOTO 20

H

HOME 17, 18
HOME_FORCE (3) 18
HOME_VEL (7) 17, 18
How SyncPos functions 6

I

IN 24
INAD 24
INDEX 17
Index 17
Installing SyncPos 8
Integral factor KINT (13) 12
Integration limit KILIM (21) 12

K

KDER (12) 12
KILIM (21) 12
KINT (13) 12
KPROP (11) 10, 12, 18

L

LOOP 17

M

MAPOS 20
Menus 7
Messages
  Attempt was made to cross arraybounds 17
  Axis no. ... not in system 17
  Compilation error 22
  Connection to ... already exists 22
  Controller is executing a program 22
  Curve array wrong 22
  Error from encoder monitoring 22
  Error in array 23
  Error in axis parameter 23
  Error in DIM command 21
  Error in global parameter 23
  Error in verifying 20
  Error not cleared 18
  Failed to move to HOME position 18
  Illegal parameter number 19
  Index pulse (encoder) not found 18
  Internal error ## 22
  Limit switch activated 20
  Lost connection to 23
  No more space for variables 21
  Parameters in EEPROM are corrupted 19
  Position error 18
  Programs in EEPROM are corrupted 19
  Reset by CPU 20
  Software limit switch activated 19
  Timeout while waiting for index. 21
  Timeout: no reply from VLT 23
  Too many interrupt functions 20
  Too many nested GOSUB commands 20
  Too many RETURN commands 20
  Too many time interrupts 21
  Unknown command 18
  User-Abort 20
MK3A 25
MK3B 25
MK3C 25
MK3D 25
MOTOR OFF 19
MOTOR ON 115

O

O.ERR_3 ... xx 18
ON APOS .. GOSUB 20
ON COMBIT .. GOSUB 20
ON INT .. GOSUB 20
ON MAPOS .. GOSUB 20
ON MCPOS .. GOSUB 20
ON PARAM .. GOSUB 20
ON PERIOD 21
ON STATBIT .. GOSUB 20
ON TIME 21
Option card layout 29
Option card terminals 24
OUT 24
OUTDA 24

P

PC Software Interface 11
PID control parameters 11
POSA 6
POSERR (15) 10
POSFACT_N (26) 6
POSFACT_Z (23) 6
Proportional factor KPROP (11) 12, 18

R

RAMPMIN (31) 6, 14, 15
RS485 connection 27

S

Safety regulations 2
Safety tips 8
Sampling time 13
SET 6
Setting of VLT parameters 8
SETVLT 19
Starting SyncPos 8
Supply voltages 28
SWNEGLIMACT (19) 19
SWPOSLIMACT (20) 19
Symbol bar 7
SyncPos Window 7
SYNCV 12

T

Table of Messages 17
Technical data 24, 26
Terminal description 24
Terminals 26
Test run program 10
TESTSTART 21
TIMER (14) 13
tolerated position error is exceeded 16

V

VEL 18
VELMAX (1) 6, 13, 14
VLT control card terminals 24
VLT parameters 8, 11
VLT software SyncPos messages 22

W

WAITNDX 17, 21
What to do if ...
maximum acceleration is not achieved 16
motor vibrates heavily 10
stationary precision is required 15
there is a tendency towards instability 15
tolerated position error is exceeded 16